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A Review of the Systematics and Ecology of the Genus "*Exosphaeroma*," with the Description of a New Genus, a New Species, and a New Subspecies (Crustacea, Isopoda, Sphaeromidae)

By Robert James Menzies[1]

INTRODUCTION AND ACKNOWLEDGMENTS

In this paper *Sphaeroma oregonensis* Dana (1852), previously placed in *Exosphaeroma* and *Neosphaeroma,* is redescribed and made the type of a new genus, *Gnorimosphaeroma.* The genus to which it belongs is restricted in its distribution to the western shores of North America and the eastern shores of Asia. All its known species are here reviewed. It has been possible in most instances to demonstrate that extra-limital references (geographic and ecologic) to *oregonensis* are in error. The genus *Gnorimosphaeroma* was found to be almost unique among the Isopoda in having both fresh- and salt-water representatives in different parts of the shores of the North Pacific Ocean. Four North American forms are described; *G. oregonensis oregonensis* (Dana); *G. oregonensis lutea,* new subspecies; *G. insulare* (Van Name); and *G. noblei,* new species.

The writer expresses his sincere thanks to Dr. James E. Lynch, University of Washington, Dr. John L. Mohr, University of Southern Cali-

[1] Contribution from the Department of Zoology, University of California, Davis, California.

fornia, and Dr. Fenner A. Chace, Jr., United States National Museum, for the loan of several specimens of *Gnorimosphaeroma*. Special thanks are due Dr. Milton A. Miller, University of California, Davis, for the loan of specimens from his collection and for very valuable advice concerning this paper. A critical evaluation of the paper by Mr. Martin Burkenroad, Institute of Marine Science, University of Texas, was of considerable value. The assistance of the American Museum of Natural History in publication is particularly appreciated.

CASES OF PROBABLY INCORRECT IDENTIFICATION

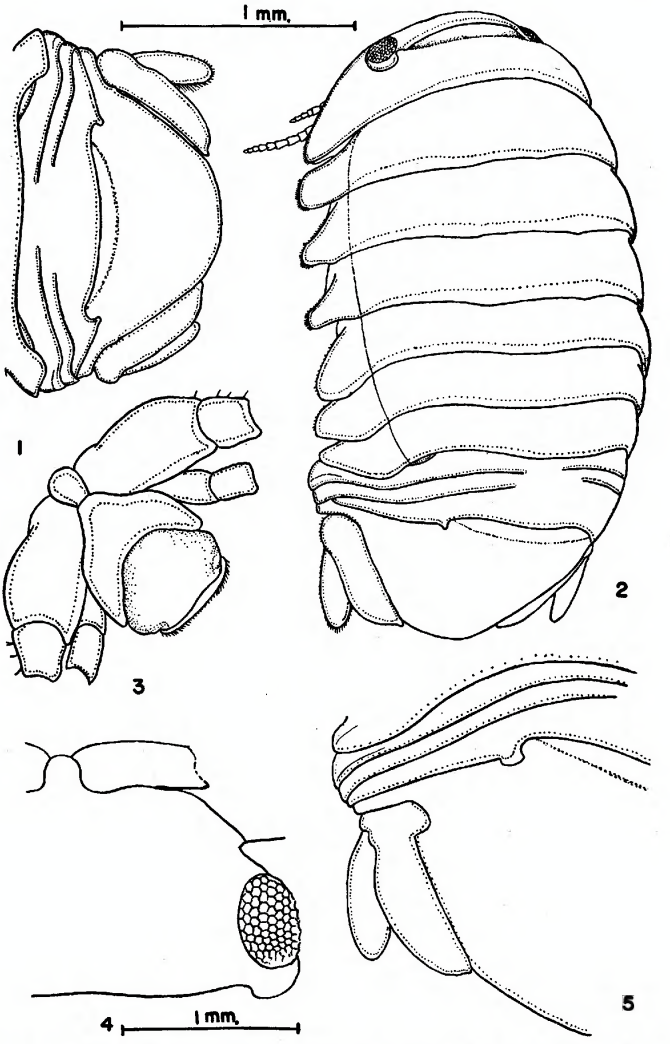
In 1852 Dana described *Sphaeroma oregonensis* from specimens collected at "Puget Sound," Washington, Oregon, and San Francisco Bay, California. His description was fair, and his illustrations (Dana, 1852–1853, 1855, atlas, pl. 52) were sufficiently accurate to permit others to recognize the species. Richardson (1905b) placed the species in *Exosphaeroma* but did not add materially to Dana's brief description. The animal is small, with no very striking characteristics, lacking spines, incisions, or tuberculations which are so diagnostic of many species of sphaeromids. Generally it is ash-gray or greenish in color, is capable of rolling into a ball, and is often very abundant. Sexual dimorphism is so very slight as to be neglected by most writers. Because of the close superficial resemblence of this species to several other nondescript isopods that occur on the west coast of North America and elsewhere, many records of its occurrence are suspect. The specimens of this species (*sensu stricto*) that the writer has seen occur in brackish or marine environments along the shores of bays and inlets. Often it has been taken at the surface of the water at night lights. At no time was it taken from fresh water or from an exposed wave-swept coast. As far as is now known, it has not been taken with certainty from outside the western coast of North America. Records of the animal from outside the habitat and range cited above can be demonstrated to be false or very doubtful in most instances.

Richardson's (1905b, p. 297) record of the species from the exposed surf at Monterey Bay, California, is certainly incorrect, in that an examination of her specimens[1] showed them to belong to a different and possibly undescribed genus. Likewise Abbott's (1940, p. 507) record of the animal from La Jolla, California, is probably a reference to the undescribed form cited by Richardson. The numerous records of *Exosphaeroma oregonensis* (Dana) from fresh water on the Pacific Coast of North America (Richardson, 1904b, 1905b; Hatch, 1947; Van

[1] Specimens lent to the writer by Dr. Fenner A. Chace, Jr., Curator, Division of Marine Invertebrates, United States National Museum, Washington, D. C.

Name, 1936) probably actually refer to the new subspecies *lutea,* which is herein described. Some of Hatch's specimens from fresh water have been examined and, in fact, show the characteristic morphology of the *lutea* subspecies.

Foreign records of the species (Thielemann, 1910, Misaki, Japan; Tat-



FIGS. 1–4. *Gnorimosphaeroma oregonensis lutea* Menzies, male. 1. Pleon and pleotelson. 2. Dorsolateral view, paratype. 3. Cephalon, frontal view. 4. Cephalon, dorsal view.

FIG. 5. *Gnorimosphaeroma oregonensis oregonensis* (Dana), pleon and pleotelson, dorsolateral view.

Figures with similar magnification: 1, 2, 5; 3, 4.

tersall, 1921, Whangpoo River, China; Uéno, 1936, Kunasiri Island, Kurile Islands) very probably are cases of misidentification, because differences between the drawings of Thielemann and Tattersall and the specimens I have seen can be detected. Thielemann's species clearly differs from the true *oregonensis* in having the more posterior suture of the last pleonal somite longer (extending farther medially) than the adjacent anterior suture. The endopod of the uropod is apically evenly rounded and lacks an acute inner distal angle which is so very conspicuous in the true *oregonensis*. Tattersall's figures of *"oregonensis* (?)" show the uropods to be similar to those figured by Thielemann, but the pleonal sutures are more nearly like those of true *oregonensis*. Uéno's reference is possibly to the form recorded by Tattersall, since the specimens of both were taken from fresh water. The uropodal endopod of *Exosphaeroma ovata* Gurjanova (1933, p. 106, Japanese Sea, intertidal) is similar to that of Tattersall's and Thielemann's species; however, the pleonal sutures more nearly resemble those of Tattersall's fresh-water form. That Tattersall and Gurjanova are not dealing with the same species is indicated by the fact that the former reported specimens from fresh water, whereas the specimens of the latter were collected from the ocean. This probably indicates that four different species, none of which is the true *oregonensis,* have been confused with Dana's species, as follows:

Exosphaeroma oregonensis (Dana), Richardson (1905b, Monterey Bay): A new species of a different genus, probably equals Abbott's reference.

Exosphaeroma oregonensis (Dana), Thielemann (1910, Japan, marine): Probably a new species.

Exosphaeroma oregonensis (Dana), Tattersall (1921, Whangpoo River, China): Probably a new species.

Exosphaeroma oregonensis (Dana), Uéno (1936, Kunasiri Island, Kurile Islands, fresh water): Possibly a new species.

GENERIC ASSIGNMENT OF *"OREGONENSIS"*

Monod (1931) removed *Sphaeroma oregonensis* Dana from *Exosphaeroma,* where Richardson had placed it, and put it in the genus *Neosphaeroma* Baker (1926, type species *Cassidina laticauda* Whitelegge, 1901). He admitted, however, that Dana's species did not correspond as well as one might wish to the type of *Neosphaeroma,* but he assumed that the differences were not of generic importance. The differences that exist, however, do seem to be of generic importance. In *Neosphaeroma* only one somite (no suture lines) comprises the contour of the exposed lateral margin of the pleon, whereas in *oregonensis* (*sensu lato*) at least two of the incomplete somites (pleonites) comprising the second pleonal

somite form the contour of the exposed lateral margin. Respiratory folds are present on pleopods three and four in *Neosphaeroma* but are lacking in *oregonensis* (*sensu lato*). The exopod of the uropods of *Neosphaeroma* is apically irregular and dentate, whereas it is smooth in *oregonensis* (*sensu lato*). Further, the ventrolateral surface of the telson has an inward projecting shelf medial to the uropods which is lacking in *oregonensis* (*sensu lato*). Monod was not aware of, or did not attach any importance to, the last two differences. Quite unfortunately Monod chose *"Sphaeroma" oregonensis* as an example of *Neosphaeroma* when he compared *Neosphaeroma* with the related genera *Exosphaeroma* and *Pseudosphaeroma.* His comparisons therefore are not entirely useful. He states, for instance, that the number of pleonites free at the lateral border and participating in the contour of the pleon in *"Neosphaeroma [australe, oregonense, pentaspina]"* is "3." In *N. laticauda* (the type species) there is only one. *Neosphaeroma australe,* a species assigned by Baker to *Neosphaeroma,* has only one pleonite exposed laterally, exactly as in *N. laticauda* (Baker, 1926, pl. 41, fig. 6), and not three as Monod indicates. *Neosphaeroma pentaspina* Baker was only doubtfully assigned to the genus *Neosphaeroma* by Baker and therefore can hardly be considered typical of that genus. *Neosphaeroma pentaspina* and *oregonensis* are indeed similar to each other and possibly belong to one genus. That they belong to *Neosphaeroma* is very doubtful for the reasons indicated above. Thus it seems very probable that *oregonensis* (*sensu lato*) and its related species should be placed in a new genus, *Gnorimosphaeroma.* The differences between *Gnorimosphaeroma, Neosphaeroma, Exosphaeroma,* and *Pseudosphaeroma* can best be seen from table 1. There it is obvious that *Gnorimosphaeroma* differs from *Neosphaeroma* as greatly as the latter does from *Pseudosphaeroma* (a genus recognized by Monod), and hence *Gnorimosphaeroma* should be considered a new genus of a rank equivalent to the others.

GNORIMOSPHAEROMA, NEW GENUS

TYPE SPECIES: *Gnorimosphaeroma oregonensis oregonensis* (Dana) equals *Sphaeroma oregonensis* Dana (1852–1853, 1855, p. 778, pl. 52, fig. 4).

DIAGNOSIS: Sphaeromidae in which the rami of the fourth and fifth pairs of pleopods lack transverse folds. Exopods of pleopods three and four biarticulate. Endopod of first male pleopod without an accessory stylus; endopod of second male pleopod with an accessory stylus which is typical in structure (not elongated and bent back upon itself). Penis of male evident but not markedly elongate, branches not sharply pointed.

TABLE 1

Diagnostic Characteristics of Four Related Sphaeromid Genera

Genus	Ventrolateral Surface of Telson with Shelf	Pleonites Reaching Lateral Margin	Respiratory Folds on Pleopods 3 and 4	Exopods of Pleopods 3 and 4	Apex of Exopod of Uropod	Apex of Telson
Gnorimosphaeroma	No	2–3	None	Biarticulate	Even	Rounded
Neosphaeroma	Yes	1	Present	Biarticulate	Dentate	Rounded
Exosphaeroma	Yes, no	1	Present	Biarticulate	Even	Rounded
Pseudosphaeroma	?	1	None	?	Even	Rounded

Both sexes similar, sexual dimorphism not pronounced. Second, third, and fourth articles of maxillipedal palp each with a produced lobe on inner margin. Exopods and endopods of uropods large, not reduced or absent, exopod not apically notched or serrated, but smoothly rounded. Pleon consisting of two somites plus a large pleotelson. First somite short, narrow, and concealed by an overlapping of the seventh peraeonal somite. Second somite large, consisting of three partly fused somites (pleonites) as indicated by the two incomplete suture lines on either side of the second pleonal "somite." The lateral borders of two or three of the pleonites reach the lateral margin of the pleon (figs. 1, 2).

Composition of the Genus *Gnorimosphaeroma*

As of this revision, the writer feels it possible to include only the species of the following list in the genus. No doubt other species belong in the genus, but they must be redescribed before accurate placement is possible. *Neosphaeroma* (?) *pentispina* Baker is a case in point. This species certainly resembles a *Gnorimosphaeroma,* but the structure of its pleopods is unknown, and although the proper number of pleonites are exposed laterally the suture lines seem to converge anteromedially, possibly indicating a structural deviation of generic significance. Hence an assignment of *pentispina* to *Gnorimosphaeroma* seems premature.

Gnorimosphaeroma oregonensis oregonensis (Dana) = *Sphaeroma oregonensis* Dana, 1852–1853, 1855, west coast of North America, sea water to brackish water.

Gnorimosphaeroma oregonensis lutea, new subspecies, west coast of North America, very brackish to almost fresh water.

Gnorimosphaeroma insulare (Van Name) = *Exosphaeroma insulare* Van Name, 1940, Nicolas Island, off California, fresh water.

Gnorimosphaeroma noblei, new species, Tomales Bay, California, sea water.

Gnorimosphaeroma chinensis (Tattersall) = *Exosphaeroma chinensis* Tattersall, 1921, Shanghai, fresh water.

Gnorimosphaeroma ovata (Gurjanova) = *Exosphaeroma ovata* Gurjanova, 1933, Japanese Sea, seashore, sea water.

Gnorimosphaeroma sp. = *Exosphaeroma oregonensis* of Thielemann, *non* Dana, Japan, seashore, sea water.

From this list it may be seen that the genus appears to be restricted to the Northern Hemisphere and to the region of the North Pacific Ocean from Japan and China to California, including Alaska. Further, the genus shows a rather unique tendency among isopods in having both salt- and fresh-water representatives.

Key to the Species of *Gnorimosphaeroma*

1. Inner apical margin of uropodal endopod acute, not evenly rounded . . . 2
   Inner apical margin of uropodal endopod evenly rounded 5
2. First articles of peduncle of left and of right first antennae meet each other on the midline of the cephalon (head) . . . . . *G. noblei*, new species

First articles of peduncle of left and of right antennae separated from each other on midline by intervention of rostrum 3

3. Frontal margin of head in anterior view (with clypeus clearly visible and first antenna removed or deflected) forms only one distinct V-shaped angle on either side of the rostrum (fig. 11) . . . . . *G. insulare* (Van Name)

Frontal margin of head in anterior view forms two distinct V-shaped angles on either side of the rostrum (fig. 12) 4

4. Only two pleonites form the lateral margin of the "second" (first visible) pleonal somite (fig. 2) . . . . . *G. oregonensis lutea*, new subspecies

Three pleonites form the lateral margin of the "second" pleonal somite (fig. 5) . . . . . *G. oregonensis oregonensis* (Dana)

5. Width of uropodal exopod less than one-half of the width of endopod . . . . . *G. chinensis* (Tattersall)

Width of uropodal exopod greater than one-half of the width of endopod . 6

6. The more posterior incomplete suture of the pleon extends farther towards the midline than the anterior incomplete suture . . . *G.* sp. (of Thielemann)

The more posterior incomplete suture of the pleon not extending so far medially as the anterior incomplete suture . . . . . *G. ovata* (Gurjanova, salt water) and *G. oregonensis* of Tattersall, fresh water (*non* Dana)

Systematics and Ecology of the American Species of *Gnorimosphaeroma*

In order to keep repetition to a minimum, generic characteristics are omitted from the diagnosis and descriptions of the species.

Gnorimosphaeroma oregonensis oregonensis (Dana), new combination

Figures 5, 7A–E, 12

Sphaeroma oregonensis Dana, 1852–1853, 1855, p. 778, pl. 52; 1856, p. 177, Richardson, 1899, p. 836; 1900, p. 223; 1904a, p. 214; 1904b, p. 659; 1905a. p. 216. Stimpson, 1857, p. 509.

Exosphaeroma oregonensis (Dana) Fee, 1926, pp. 28–29. Hatch, 1947, p. 213, figs. 82–83. Richardson, 1905b, pp. 296–298, figs. 315–316; 1909, p. 92. Van Name, 1936, pp. 450–451, fig. 282.

Exosphaeroma oregonense (Dana) Van Name, 1940, pp. 125–126, fig. 17.

Neosphaeroma oregonense (Dana) Monod, 1931, pp. 67–82, fig. 74.

Sphaeroma olivacea Lockington, 1877, p. 45.

As is indicated above, Dana's description of the species was quite adequate, hence the synonymy is not particularly complicated. Confusion arose only when workers attempted to identify exotic and fresh-water forms with Dana's species. Such references, of course, cannot be included in the synonymy of this species (*sensu stricto*), and readers are referred to the introductory remarks of this paper for a clarification of some disputed synonyms. Several of the above references are to both subspecies. Thus Richardson and Hatch record both, and Van Name describes the fresh-water form while giving figures of the marine subspecies. Such

references will accordingly be duplicated in the synonymy for the *lutea* subspecies.

DIAGNOSIS: Each eye with more than 64 ocelli. Frontal process (rostrum) and clypeus meet on the midline. First articles of peduncle of first antennae separated from each other by the intervention of the rostrum and clypeus. Frontal margin (with clypeus in full view) presents two V-shaped projections in outline on either side of rostrum. Each maxilliped with one major coupling hook and a narrower, smaller, accessory coupling hook. Left mandible with a well-developed, three-toothed lacinia mobilis. Propodus of first peraeopod with about four compound toothed setae on inferior margin. Male stylus of second pleopod only slightly exceeds the distal margin of endopod in length. Exopods of pleopods three, four, and five biarticulate, endopods uniarticulate. Exopod of pleopod five with three swollen, scale-bearing areas on inner margin. Apical article of exopod of fourth pleopod with several plumose setae on distal margin. Endopod of pleopod four and both rami of pleopod five lack plumose setae. The three partial somites (pleonites) which make up the second "somite" all extend to the lateral margin of the pleon; first incision extending medially farther than second incision. Exopod of uropod about one-fourth as long as endopod which has an acute inner distal margin; both rami smooth, lacking spines or crenulations, but margins provided with setae.

TYPE LOCALITY: "Puget's Sound, Oregon; also Bay of San Francisco collected by Dr. C. Pickering" (Dana, 1852-1853, 1855, vol. 13, pt. 2, p. 778). It would seem desirable to select Puget Sound, Washington, the first locality mentioned by Dana, as the type locality in order to obviate any confusion which may arise.

LOCATION OF TYPES: The types of this species have probably been destroyed, and to date no new types have been selected.

MEASUREMENTS: Dana gave no measurements. Fee (1926) records the largest specimens as being "about 1 cm. long; one-half as long as wide." Hatch (1947) found specimens as long as 1.2 cm. Richardson (1905b, p. 297) records the length as 0.8 cm. Populations examined by the writer varied considerably in size; the largest were between the measurements given above, and the small ones were about 0.40 cm. in length and 0.25 cm. in width. Generally the females were considerably smaller than males of the same population.

ECOLOGY: All the specimens examined by the writer were collected from water classified as salt water, but the salinity was found to be markedly variable. At Point San Quentin, Marin County, San Francisco Bay, specimens were taken in water having a salinity of only 9.06 parts

per thousand, whereas specimens collected at Shell Beach, Marin County, Tomales Bay, were found in the much more saline water of 30.90 parts per thousand. The results of an experiment (table 2) show the inability of even the specimens from Point San Quentin to withstand submersion in tap water. Within one day all specimens placed in tap water were dead, but the control specimens in the water of the habitat were living.

The records indicate the species to be typically intertidal, inhabiting the under surfaces of stones, empty *Bankia* holes, and the like. Dr. John L. Mohr's finding of specimens at the surface of the water at a night light indicates, however, that the species does occasionally enter the planktonic environment. Hatch (1947) records the species from depths as great as 12 fathoms as well as at submerged night lights.

DISTRIBUTION: Ranges from Alaska to San Francisco Bay, California; intertidal to 12 fathoms; salinities encountered, 9.06 parts per thousand to 30.90 parts per thousand.

RECORDED DISTRIBUTION: *Bering Island:* (Richardson). *Alaska and vicinity:* Alert Bay, Kodiak, Sitka, Kyska, Saginaw Bay, North Grebnitzky (Richardson), Baranof Island, Ketchikan (Hatch), Nazan Bay, Atka, Unalaska, Attu, Yakutat, Glacier Bay (Richardson). *British Columbia:* Gulf of Georgia, Grenville Channel, Lowe Island (Richardson), Newcastle Island, Margaret Bay, Taylor Bay, Pilot Bay, Departure Bay (Fee), Vancouver (Hatch). *Washington:* Edmonds, Everett, Port Angeles (Hatch); Puget Sound (Stimpson), San Juan Arch at Deadman Bay, False Bay, Friday Harbor, James Island, Lopez Island, Peavine Pass; Seattle at Alki Point, Golden Gardens, Carkeek Park; South Bend (in slough); Vashon Island, Whidbey Island, Willapa Bay (Hatch), Shoalwater Bay (Stimpson). *Oregon:* Coos Bay, Glenada (Hatch). *California:* San Francisco Bay (Dana, Lockington).

MATERIAL EXAMINED: *Alaska:* Alert Bay, February 21, 1882 (W. Jones, United States Navy), 54 specimens (U.S.N.M. No. 5720). *Washington:* Seattle, May 12, 1941 (James E. Lynch), intertidal zone, from holes made by *Bankia setacea* in a log, 10 females (ovigerous), 26 males. Tacoma,[1] August, 1934 (S. F. Light), four males, three females (collection M. A. Miller); Puget Sound ("Albatross," U.S.N.M. No. 22696); San Juan Island, Friday Harbor, University of Washington Oceanographic Laboratories, August 16, 29, 1949 (John L. Mohr), at nightlight, one male, five females. *Oregon:* Coos Bay, Coos County, by South Loading Dock, August 28, 1950 (John L. Mohr), in *Nereocystis* hapter, two females. *California:* Point San Quentin,[1] Marin County, San Francisco Bay, February 24, 1949, May 17, 1952 (R. J. Menzies, 1949; R. J.

[1] New locality.

Menzies and Raymond Meek, 1952), under stones, intertidal, salinity 9.06 parts per thousand (1952); Berkeley Beach,[1] Berkeley, San Francisco Bay, June, 1934 (Olga Hartman), under stones, intertidal, one male, six females (four ovigerous), two juveniles (collection M. A. Miller); Shell Beach,[1] Tomales Bay,[1] Marin County, May 17, 1952 (R. J. Menzies and Raymond Meek), under stones, intertidal, with *Porichthys notatus,* salinity 30.90 parts per thousand.

REMARKS: From the above records it seems evident that this species is marine, primarily intertidal in habitat, and is not known south of San Francisco Bay, California.

The subspecies can be easily distinguished from *lutea* by the fact that three rather than two pleonites of the "second" pleonal somite reach the lateral margin.

Of further interest is the fact that although in nature the subspecies normally tolerates a salinity as low as 9.06 parts per thousand the animal is none the less not capable of surviving immersion in tap water. This may or may not be an important point, because of the possibility that the animals could have become acclimated to the tap water were the transition gradual. Richardson's (1905b, fig. 315) and Hatch's (1947, fig. 82) reproductions of Dana's figure of the species are incorrect in regard to the length of the sutures on the "second" pleonal somite owing to the fact that the first is represented as being shorter than the second. Beyond the correction of this error there is no necessity for enumerating discrepancies between earlier descriptions of the species and the actual specimens.

TABLE 2

SURVIVAL OF *Gnorimosphaeroma oregonensis oregonensis* TRANSFERRED FROM SALT WATER OF LOW OR HIGH SALINITY TO TAP WATER

	Point San Quentin	Shell Beach, Tomales Bay
Salinity of original habitat	9.06‰	30.90‰
Experimental, transferred to tap water of salinity 0.12‰		
No. of specimens	8	3
No. of specimens surviving after 24 hours	0	0
Control, kept in habitat water		
No. of specimens	6	3
No. of specimens surviving after 24 hours	6	3

[1] New locality.

Gnorimosphaeroma oregonensis lutea, new subspecies

Figures 1–4, 6

Sphaeroma oregonensis Dana, RICHARDSON, 1904b, p. 659 ("Popof" Island, record from fresh water).

Exosphaeroma oregonensis (Dana), HATCH, 1947, p. 213 (records from fresh water). VAN NAME, 1936, pp. 450–451 (not the figure), gives Richardson's (1904b) record.

It is impossible, of course, to extract all references to this subspecies from prior records to *Exosphaeroma oregonensis* Dana, but the above references to the species from fresh water probably are of the *lutea* subspecies.

DIAGNOSIS: The diagnosis for this subspecies is the same as that given for *Gnorimosphaeroma oregonensis oregonensis* (Dana), except that only two pleonites reach the lateral border of the "second" pleonal somite.

TYPE LOCALITY: Shell Beach, Marin County, Tomales Bay, California, May 3, 1952 (Milton A. Miller, Lloyd Tevis, and R. J. Menzies), under log at fresh-water seepage pond near bay, 75 females (74 ovigerous), eight males.

LOCATION OF TYPES: The holotype male (A.M.N.H. No. 11546), allotype female (A.M.N.H. No. 11547), and 25 female and four male paratypes (A.M.N.H. No. 11548) are deposited in the collections of the American Museum of Natural History. Other paratypes are located as follows: 20 in the United States National Museum and 45 in the Museum of the Department of Zoology, University of California, Davis, California.

MEASUREMENTS: Holotype male: length, 8.5 mm.; width of telson, 4.1 mm. Allotype (ovigerous): length, 5.3 mm.; width of telson, 2.3 mm.

ECOLOGY: All specimens examined by the writer were collected from water classified as fresh or only very slightly salt. The specimens were usually found in muddy waters but were once collected from very clear water. They were found in association with typically fresh-water plants and insects, and also with brackish-water algae such as *Entermorpha.* At one locality they were taken with a species of Mysidacea. The salinities tolerated normally by the subspecies *lutea* were of a much smaller range and magnitude than those encountered for *oregonensis* (*sensu stricto*), e.g., from 0.48 parts per thousand at Stemple Creek to 2.20 parts per thousand at the Napa River.

An experiment designed to determine the ability of *lutea* to withstand submersion in very saline water gave somewhat confusing results (table 3). It was thought that tap water at Davis[1] might act as a control be-

[1] Salinity determined from chlorinity titration (Mohr method) with the use of Knudsen tables.

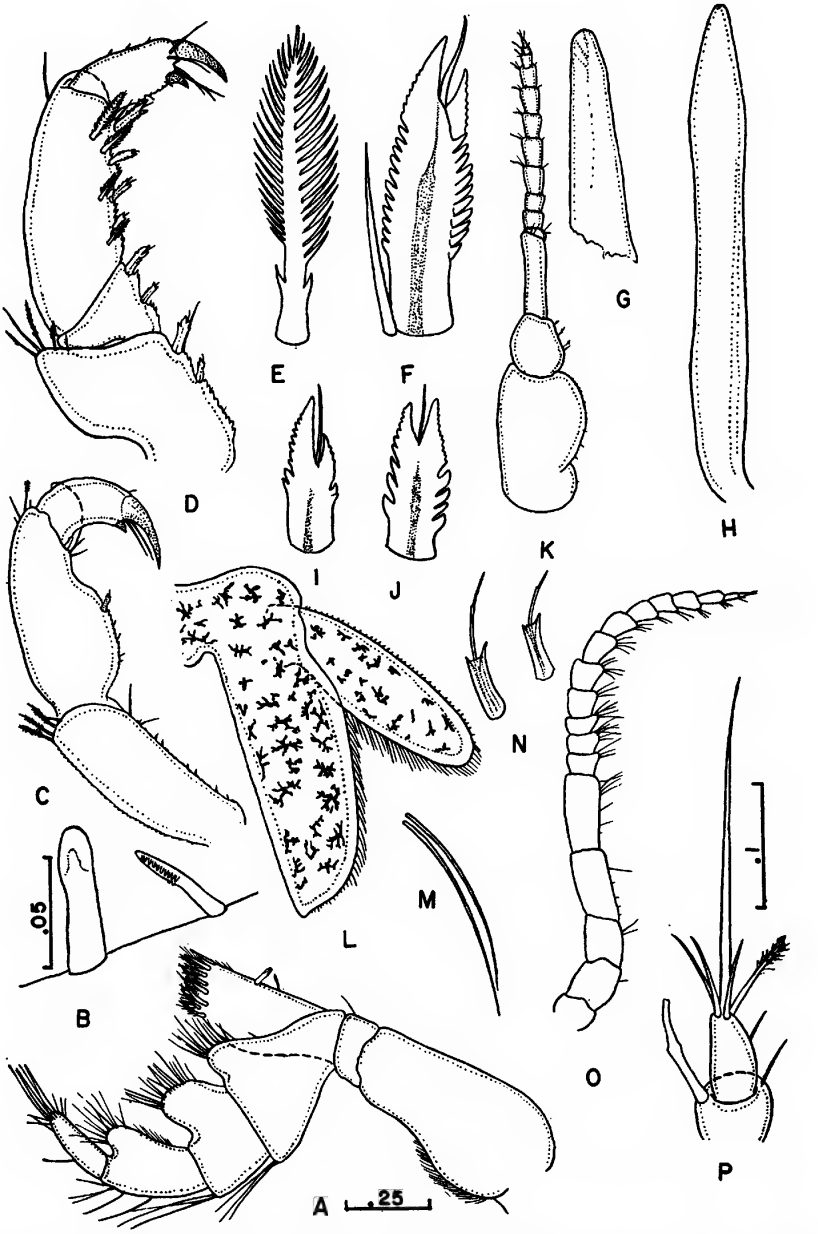


FIG. 6. *Gnorimosphaeroma oregonensis lutea* Menzies, male. A. Maxilliped. B. Maxillipedal coupling hooks. C. Second peraeopod. D. First peraeopod. E, F. Setae on first peraeopod. G. Right ramus of penis. H. Stylus of second pleopod. I, J. Setae on first peraeopod. K. First antenna. L. Uropod. M, N. Setae on margin of uropod. O. Second antenna. P. Distal article of first antenna.

Figures with similar magnification: A, C, D, G, H, L, K, O; B, E, F, I, J, M, N; P.

cause its salinity (0.12‰) was only 0.45 parts per thousand lower than that of the habitat water at Shell Beach. This does not seem to be the case, however, because the animals that were taken from the "fresh water" of Shell Beach and placed in tap water slowly died, whereas all but one of 12 specimens transferred to water of a high salinity (30.90‰) survived for the duration of the experiment. This experiment certainly does not explain why *lutea* is not normally found in very saline waters.

TABLE 3

SURVIVAL OF *Gnorimosphaeroma oregonensis lutea*, TRANSFERRED FROM HABITAT WATER (SALINITY 0.57 PARTS PER THOUSAND) AT SHELL BEACH TO TAP WATER AND SALT WATER

	Placed in Tap Water, Salinity 0.12‰	Placed in Salt Water, Salinity 30.90‰
Experimental group	12	12
Number surviving		
One day	6	11
Two days	2	11
Three days	0	11

The writer fully expected the animals to die in the salty water owing to dehydration of tissues, providing a simple explanation of their absence from very saline water. Their gradual death in tap water might be explained as being due to a need of the animals for a slight concentration of salt (greater than that of the tap water) or to the possible presence of toxins in the tap water. Certainly more adequate and extensive experimentation is suggested to explain the odd results, especially to explain the restriction of the animals in nature to waters of very low salinity ("fresh water") even though they are quite obviously capable of living in water of near oceanic salinity for at least several days without apparent injury.

DISTRIBUTION: Range: Popov Island, Alaska to Salinas River, Monterey County, California.

RECORDED DISTRIBUTION: *Alaska:* "Popof" Island (Richardson). *British Columbia:* Vancouver (Hatch). *Washington:* Nasel River (Hatch). *Oregon:* Fletcher Lake, Depoe (Hatch).

MATERIAL EXAMINED: *Washington:* South of Edmonds, Snohomish County, May, 1946 (James E. Lynch), from a brackish-water pond on railroad right of way, 26 males, 30 females. *Oregon:* Depoe, near Spouting Horns, August 6, 1933 (James E. Lynch), fresh-water pool on top

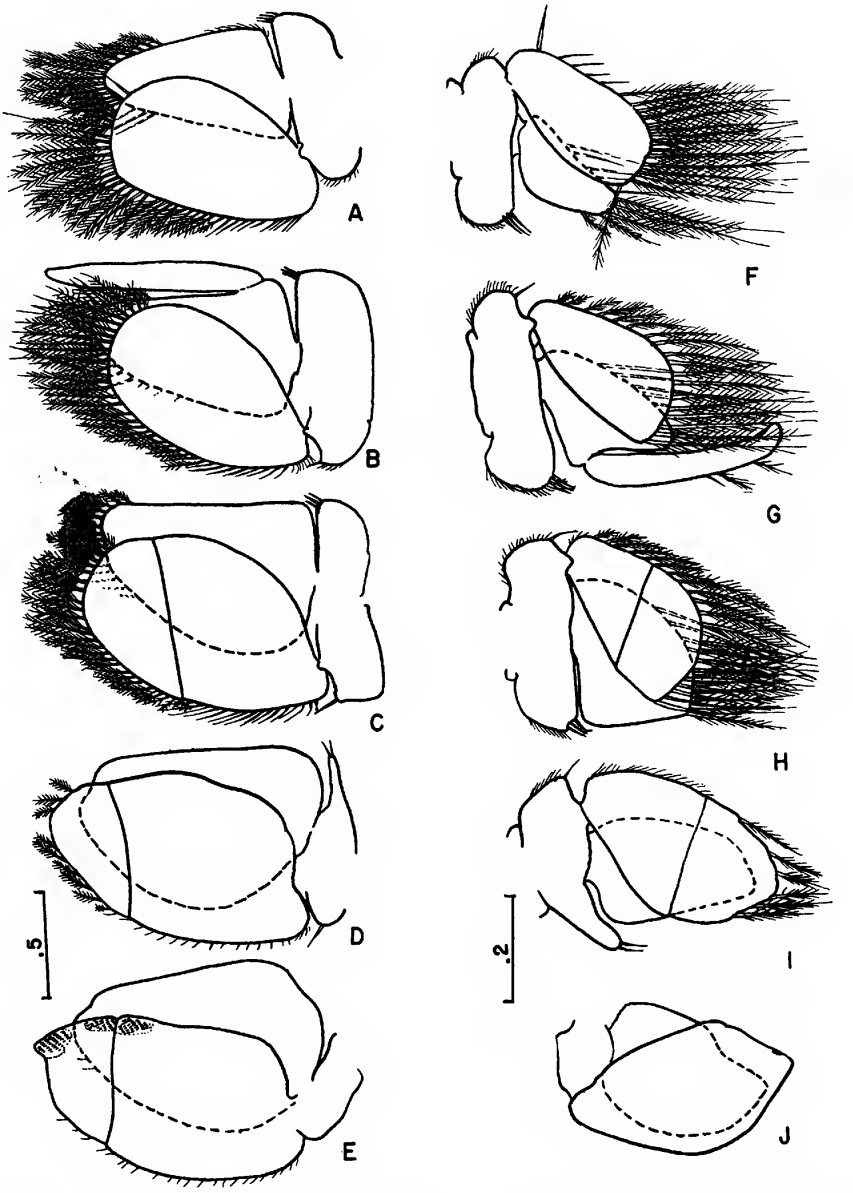


FIG. 7. Male pleopods 1–5 in sequence. A–E. *Gnorimosphaeroma oregonensis oregonensis* (Dana). F–J. *Gnorimosphaeroma noblei* Menzies.
Figures with similar magnification: A, B, C, D, E; F, G, H, I, J.

of rock near the bay, pools 3–11 feet in diameter, 1–2 inches deep, and tasted fresh, with a growth of *Enteromorpha,* 300± specimens. *California:* Walker Creek,[1] Marin County, May 17, 1952 (R. J. Menzies and Raymond Meek), under stones, salinity 1.47 parts per thousand, 21 males, two females, six juveniles. Stemple Creek,[1] Marin County, about 0.8 mile west of town of Fallon, 1947 (R. J. Menzies), and May 17, 1952 (R. J. Menzies and Raymond Meek), water clear, insects, Mysidacea, and *Diaptomus* present, salinity 0.48 parts per thousand, 22 males, 49 females (one ovigerous), 22 juveniles; 2 miles east of ocean in mud channels, 1947 (R. J. Menzies), water fresh to taste, eight males, 26 females (ovigerous). Shell Beach,[1] Tomales Bay, Marin County, May 3, 17, 1952 (Milton A. Miller, Lloyd Tevis, R. J. Menzies, and Raymond Meek), 75 females (74 ovigerous), eight males, plus 25 males, females, May 17, salinity 0.57 parts per thousand, from water on edge of bay supplied by seepage of a near-by spring. Napa River[1] at Mare Island, bridge on Black Point Road, May 17, 1952 (R. J. Menzies and Raymond Meek), mud, under wood, near a growth of cattail plants, salinity 2.19 parts per thousand, 15 males, 72 females (70 ovigerous). San Joaquin River[1] at mouth of Mokelumne River, April 15, 1948 (O. B. Cope), one male and one female (U.S.N.M. No. 179195). La Honda,[1] September 18, 1933 (Richard M. Eakin), fresh water, under rocks, 11 females (collection Milton A. Miller, No. 68). Lake Merced,[1] San Francisco, August 22, 1945 (Leo Shapovalov), water fresh, four specimens. Mouth of Salinas River,[1] Monterey County, July 23, 1947 (Ralph I. Smith), on submerged log in debris, two males.

REMARKS: From the above records it seems evident that *lutea* is primarily an inhabitant of fresh or very slightly saline waters, mixing at times with typically fresh-water species. Purely preliminary experiments indicate the subspecies possibly is unable to survive in tap water.

That female specimens in general are much smaller than male specimens is clearly indicated in table 4 which gives measurements and sex of the specimens collected by James E. Lynch from Snohomish County, Washington. In nature, female specimens are often observed to be covered by the large male, with the dorsal surface of the female against the ventral surface of the peraeon of the male. It is possibly in this attitude that fertilization is accomplished. Sexually mature male specimens were noted at a length of 3.8 mm. and over; sexually immature specimens were found at a length of 4.0 mm. and less. All female specimens were either ovigerous or had ripe ovaries.

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[1] New locality.

There exists the possibility that *lutea* does not represent a subspecies in the genetic sense of the word. The morphological differences might be induced by salinity. Either point would be difficult to determine without extensive breeding and acclimatization studies.

TABLE 4

COMPARISON OF LENGTH AND SEXUAL DEVELOPMENT OF SPECIMENS OF *Gnorimosphaeroma oregonensis lutea*, NEW SUBSPECIES, FROM SNOHOMISH COUNTY, WASHINGTON

(Females with ripe ovaries and ovigerous females are considered to be sexually mature.)

Sexual Development	Number Measured	Length in Mm.	
		Range	Mean $\pm \sigma$
Mature males	22	3.8–5.0	*4.3 ± 0.38*
Immature males	4	3.5–4.0	*3.7 ± 0.21*
Mature females	31	2.2–3.8	*2.9 ± 0.35*

Gnorimosphaeroma insulare (Van Name)

Figures 10, 11

Exosphaeroma insulare VAN NAME, 1940, pp. 125–126, fig. 17A, B.

DIAGNOSIS AND REMARKS: Van Name compared this species with specimens of *Gnorimosphaeroma oregonensis oregonensis* (Dana), and hence it may be assumed that *G. insulare* has the essential generic characteristics. To judge from Van Name's figure, *G. insulare* differs from the subspecies *G. o. oregonensis* and *G. o. lutea* in the angulation, length, and relationship of the pleonal sutures on the second somite, e.g., the most anterior suture does not extend so far medially as the posterior one, but the reverse is true in both *oregonensis* and *lutea*. In the number of pleonites exposed laterally *insulare* resembles *oregonensis* and not *lutea*. The front of the head of *insulare* differs from that of *oregonensis* and *lutea* in being almost straight and having only one V-shaped margin lateral to the rostrum and not two as in *oregonensis* and *lutea*. The structure of the endopod of the uropod was not described by Van Name. However, in view of the species he used for comparison, it may be assumed that it is identical with that of the *oregonensis* subspecies.

The present writer has not seen specimens of *G. insulare*, and the above diagnosis and remarks are therefore derived entirely from Van Name's description.

TYPE LOCALITY: San Nicolas Island, off the coast of southern California, date unknown (T. D. A. Cockerell), fresh water, with *Physa virgata* Gould, 11 specimens (data from Van Name).

LOCATION OF TYPES: The American Museum of Natural History (A.M.N.H. No. 8092).

MEASUREMENTS: Largest specimen: length, 8 mm.; width, 4 mm.

ECOLOGY: An inhabitant of fresh water.

DISTRIBUTION: Known only from the type locality.

Gnorimosphaeroma noblei, new species

Figures 7F–J, 8–9

DIAGNOSIS: Each eye with 20 to 25 ocelli. Frontal process separated from clypeus by basal articles of peduncles of first antennae which approximate each other on the midline. Each maxilliped with one coupling hook. Left mandible lacks a true lacinia mobilis. Propodus of first peraeopod with four dentate but simple setae on inferior margin. Male stylus of second pleopod extends one-half of its length beyond distal margin of endopod. Exopods of third and fourth pleopods biarticulate. Exopod of fifth pleopod uniarticulate and lacks swollen scale-bearing areas on inner margin. Apical article of exopod of fourth pleopod with several plumose setae, endopod without plumose setae. Both rami of fifth pleopod lack setae. The three pleonites which make up the second "somite" all extend to the lateral margins of the pleon; first incision not extending so far medially as second incision. Exopod of uropod one-third as long as endopod, which has an acute inner distal margin, both rami smooth, lacking spines or crenulations but margins are provided with setae.

DESCRIPTION: Cephalon and antennae: Cephalon small, with a minute frontal process (rostrum). Peduncle of first antenna with a swollen basal article, second article one-half of the length of first, third article one-third longer than second; flagellum with seven articles. Flagellum of second antenna with 11 articles.

Oral Appendages: Second maxillary inner lobe with seven apical setae, outer lappet of outer lobe with three apical setae, inner lappet with four apical setae. First maxillary inner lobe with about seven apical setae, outer lobe with four apical setae. Palp of mandible triarticulate, first and second articles elongate, subequal in length, terminal article less than one-half of the length of second. Left mandibular incisor with three teeth and a cutting flange, setal row with a lacinioid seta, to which are attached three plumose setae; molar process expanded, with about 130 teeth on molar surface; true lacinia mobilis lacking. Right mandibular incisor with three teeth, setal row with four setae.

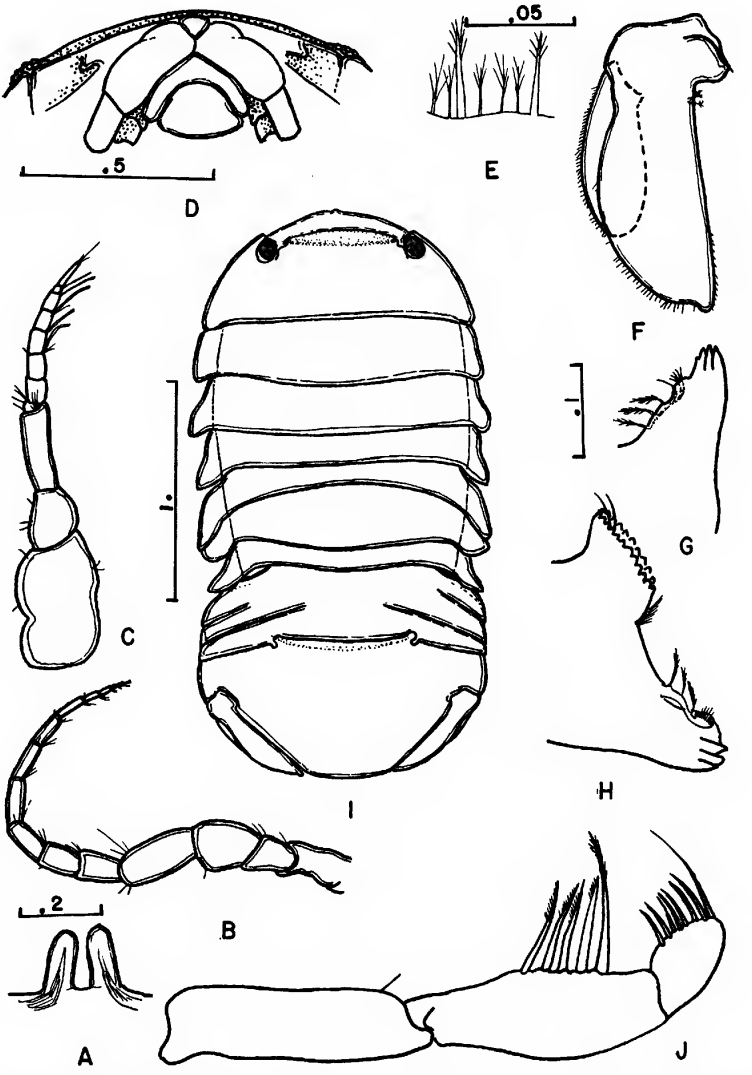


FIG. 8. *Gnorimosphaeroma noblei* Menzies. A. Penis. B. Second antenna. C. First antenna. D. Front of head. E. Margin of endopod of uropod. G. Right mandible, incisor and setal row. H. Left mandible, incisor, setal row, and molar process. I. Holotype, dorsal view. J. Mandibular palp.
Figures with similar magnification: A, B, C, F; D; E; G, H; I; J (not known).

Peraeonal appendages: Propodus of first peraeopod not swollen, with four dentate simple setae on inferior margin. Other peraeopods more elongate than first, propodal article lacking dentate setae. Rami of penis not united at base.

Pleonal appendages, male: Exopod of first pleopod with about 15

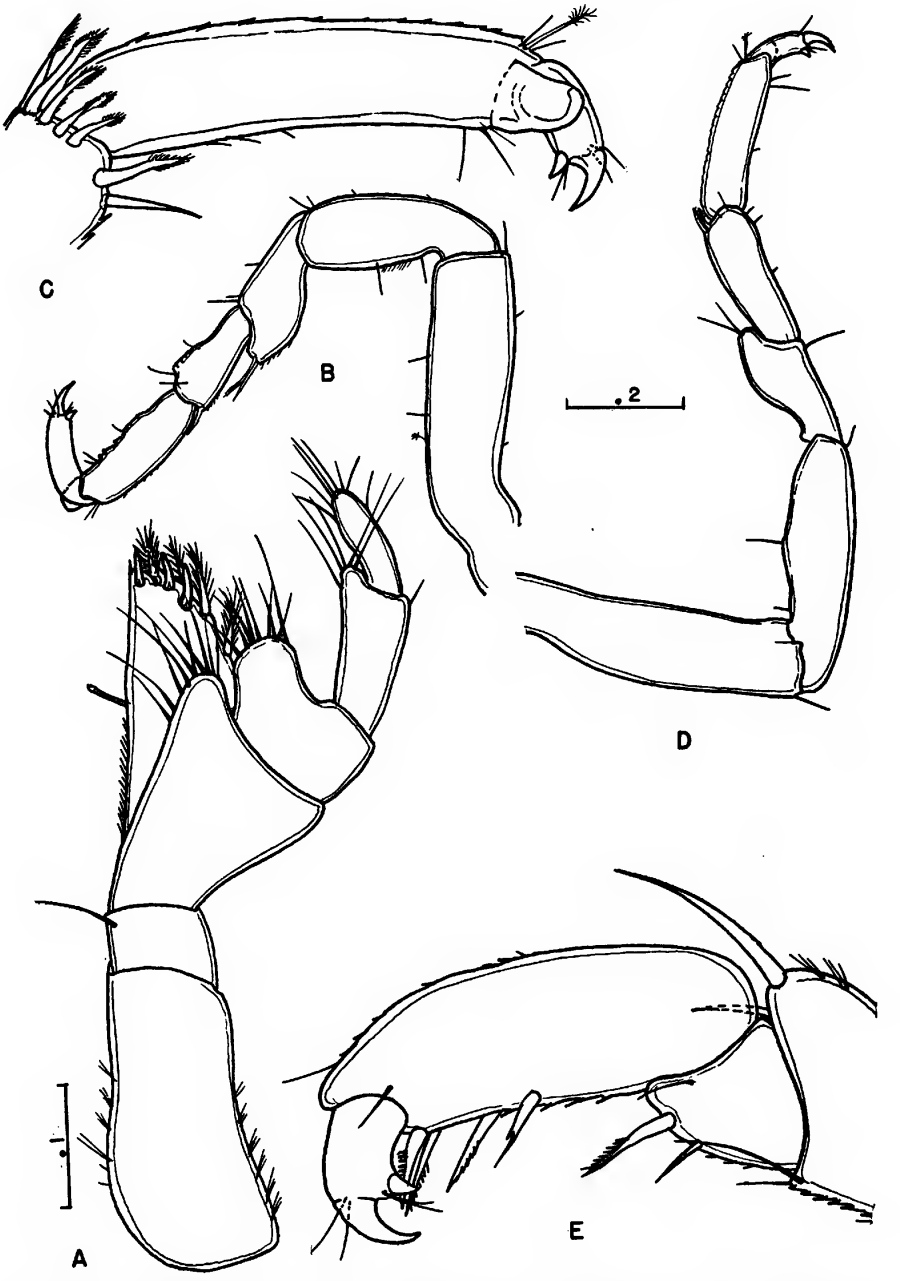


FIG. 9. *Gnorimosphaeroma noblei* Menzies. A. Maxilliped. B. Second peraeopod. C. Seventh peraeopod. D. Third peraeopod. E. First peraeopod. Figures with similar magnification: A, C, E; B, D.

plumose marginal setae, endopod with about five plumose marginal setae. Exopod of second pleopod with about 18 plumose marginal setae, endopod with about nine plumose marginal setae. Exopod of third pleopod with about 21 plumose marginal setae, endopod with about 11 plumose marginal setae, exopod biarticulate. Exopod of fourth pleopod with six plumose apical setae, endopod lacks plumose setae.

Peraeon: Dorsal surface smooth. Faint lines mark the place where the coxal plates are fused with the second to seventh peraeonal somites inclusive.

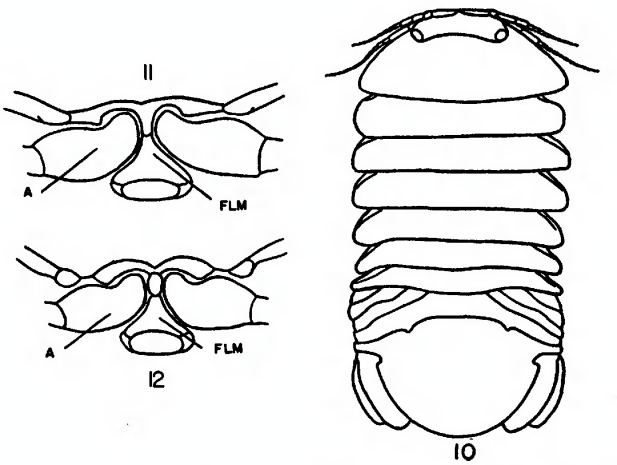
Pleotelson: Dorsal surface smooth. Apex of telson bluntly rounded, uropods not extending beyond the posterior margin.

MEASUREMENTS: Holotype male: length, 2.9 mm.; width (at second peraeonal somite), 1.4 mm. Allotype, ovigerous: length, 2.0 mm.; width, 0.9 mm.

ECOLOGY: The ecology of this species is rather interesting. The animals were found under stones and rocks in the upper part of the intertidal zone. High in their ecologic range they were found in association with the halophil terrestrial isopod *Armadilloniscus;* unlike the latter, however, the sphaeromids were also found to about the mean high-water line under barnacle-encrusted rocks and were excellent swimmers.

DISTRIBUTION: Known only from type locality.

TYPE LOCALITY: From the town of Marshall southward along Tomales



FIGS. 10, 11. *Gnorimosphaeroma insulare* (Van Name). 10. Dorsal view (length of specimen, 8 mm.). 11. Dorsal view, frontal margin, bases of first antennae (A), and frontal lamina (FLM).

FIG. 12. *Gnorimosphaeroma oregonensis oregonensis* (Dana)?, frontal margin, same details as in figure 11. After Van Name, 1940.

Bay, Marin County, California. The species, thus far, has been collected only at the following places in Tomales Bay: Marshall, holotype, allotype, and two males, two females (ovigerous), February 14, 1948 (R. J. Menzies), under rocks with *Armadilloniscus holmesi* Arcangeli; three males, four females (three ovigerous), May 2, 1952 (R. J. Menzies and M. A. Miller), under rocks covered by barnacles; 1 mile south of Marshall, two males, 12 females (two ovigerous), February 19, 1949 (R. J. Menzies), upper intertidal zone under rocks with a green nemertine worm; Shell Beach, one male, 67 females (65 ovigerous), May 3, 1952 (R. J. Menzies, Lloyd Tevis, and M. A. Miller), upper intertidal, under rocks, with *Armadilloniscus coronacapitalis* Menzies.

Location of Types: The holotype (A.M.N.H. No. 11549), allotype (A.M.N.H. No. 11550), and 71 paratypes (A.M.N.H. No. 11551) are in the American Museum of Natural History. Fourteen paratypes are in the Museum of the Department of Zoology, University of California, Davis, California, and seven paratypes are in the United States National Museum.

Remarks: This species can be separated from other members of the genus by the arrangement of the somite incisions on the second pleonal somite, by the absence of a true lacinia mobilis, by the approximation of the first articles of the peduncle of the first antennae on the midline, and by the fact that the dorsal surface of the animal lacks tubercles or rugosities. The species is named in honor of Dr. Alden E. Noble, Director, Pacific Marine Station, College of the Pacific, Dillon Beach, California, in appreciation of his constant encouragement of the writer's work on isopods.

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